

# Understanding Critical Values for Hypothesis Testing in Google Sheets

Authored by  
**Mohammed looti**

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In the realm of quantitative analysis, performing a [hypothesis test](#) is fundamental for drawing reliable conclusions from data. The immediate output of this process is the calculation of a [test statistic](#). However, determining if this result is meaningful--that is, if it possesses [statistical significance](#)--requires comparing the statistic against a predefined numerical boundary: the **critical value**.

The **critical value** is fundamentally important as it defines the precise threshold separating the rejection region from the acceptance region of the null hypothesis. If the absolute magnitude of the calculated test statistic exceeds this [critical value](#), the evidence is considered sufficiently compelling to warrant the rejection of the null hypothesis, thereby confirming the statistical strength of the findings. This guide provides a detailed walkthrough of how to efficiently calculate these crucial values directly within [Google Sheets](#).

## Mastering T-Critical Value Calculation in Google Sheets

The **t-critical value** is essential when conducting a t-test, particularly in scenarios characterized by small sample sizes (typically  $N < 30$ ) or when the population standard deviation remains undefined. In these conditions, we must rely on the [Student's t-distribution](#), which accounts for the increased uncertainty inherent in smaller datasets. Fortunately, [Google Sheets](#) offers powerful inverse distribution functions designed specifically to calculate these critical thresholds accurately.

To successfully calculate the **t-critical value**, two parameters are indispensable: the desired probability, often represented by the alpha level or [significance level](#), and the [degrees of freedom](#) (df), which relates directly to the sample size (typically  $N - 1$ ). The choice of function depends entirely on whether the statistical hypothesis test is one-tailed or two-tailed.

The following functions provide the necessary syntax for determining the t-critical threshold within the spreadsheet environment:

**T.INV(probability, deg\_freedom)**: This function is tailored for determining the **t-critical value** associated with a **one-tailed t-test**. The input probability should represent the total area of the single tail.

**T.INV.2T(probability, deg\_freedom)**: Conversely, this function is used for a **two-tailed t-test**. It automatically divides the input probability (alpha) across both the upper and lower tails, returning the positive critical value required for comparison.

## Calculating Z-Critical Values Using the Standard Normal Distribution

When dealing with sufficiently large sample sizes ( $N > 30$ ) or, critically, when the population standard deviation is known, statistical analysis shifts from the t-distribution to the [Standard Normal Distribution](#) (Z-distribution). In these contexts, we calculate the **z-critical value**. A significant

advantage here is that the z-critical value is independent of the sample size and [degrees of freedom](#), simplifying the required inputs.

The primary required input for finding the **z-critical value** is the desired [significance level](#) (alpha). Google Sheets employs the inverse of the standard normal cumulative distribution function to derive this critical boundary. This powerful function allows researchers to quickly identify the precise point on the distribution curve that corresponds to their chosen significance threshold.

Here is the specific function syntax for calculating z-critical values based on the type of test:

**NORM.S.INV(probability)**: This formula returns the **z-critical value** for a **one-tailed z-test**. The probability argument should be the alpha level (e.g., 0.05) if looking for the lower tail critical value.

**NORM.S.INV(probability/2)**: This variant is used for a **two-tailed z-test**. Since a two-tailed test splits the alpha risk into two equal regions, the probability input must be halved (e.g., 0.05 becomes 0.025) to find the critical boundary of the lower tail.

To solidify understanding, the subsequent sections provide four practical, step-by-step examples demonstrating how to apply these functions effectively within [Google Sheets](#) for both T and Z distributions.

### Example 1: Determining the Critical Value for a One-Tailed T-Test

Consider a scenario requiring a left-tailed [hypothesis test](#) utilizing the t-distribution. We establish the required [significance level](#) (alpha) at 0.05, indicating a 5% risk of Type I error. Furthermore, based on our sample size, we have determined the [degrees of freedom](#) (df) to be 11. To accurately identify the corresponding t-critical threshold, we use the **T.INV** function, inputting the alpha level and the df:

|    | A            | B | C | D |
|----|--------------|---|---|---|
| 1  | -1.795884819 |   |   |   |
| 2  |              |   |   |   |
| 3  |              |   |   |   |
| 4  |              |   |   |   |
| 5  |              |   |   |   |
| 6  |              |   |   |   |
| 7  |              |   |   |   |
| 8  |              |   |   |   |
| 9  |              |   |   |   |
| 10 |              |   |   |   |
| 11 |              |   |   |   |
| 12 |              |   |   |   |
| 13 |              |   |   |   |
| 14 |              |   |   |   |
| 15 |              |   |   |   |
| 16 |              |   |   |   |
| 17 |              |   |   |   |

The execution of this formula results in a **t-critical value** of **-1.79588**. This value serves as the rejection boundary. Therefore, if our calculated [test statistic](#) falls below this threshold (e.g., -2.0), we possess sufficient evidence to reject the null hypothesis.

## Example 2: Finding the Critical Boundaries for a Two-Tailed T-Test

A two-tailed test requires us to identify extreme deviations from the mean in both the positive and negative directions simultaneously. Maintaining the same statistical parameters--a [significance level](#) (alpha) of 0.05 and 11 [degrees of freedom](#)--we must utilize the **T.INV.2T** function, which is designed to handle the symmetrical distribution of alpha across the two tails of the [Student's t-distribution](#):

|    | A                            | B | C | D | E |
|----|------------------------------|---|---|---|---|
| A1 | $\text{=T.INV.2T}(0.05, 11)$ |   |   |   |   |
| 1  | 2.20098516                   |   |   |   |   |
| 2  |                              |   |   |   |   |
| 3  |                              |   |   |   |   |
| 4  |                              |   |   |   |   |
| 5  |                              |   |   |   |   |
| 6  |                              |   |   |   |   |
| 7  |                              |   |   |   |   |
| 8  |                              |   |   |   |   |
| 9  |                              |   |   |   |   |
| 10 |                              |   |   |   |   |
| 11 |                              |   |   |   |   |
| 12 |                              |   |   |   |   |
| 13 |                              |   |   |   |   |
| 14 |                              |   |   |   |   |
| 15 |                              |   |   |   |   |
| 16 |                              |   |   |   |   |
| 17 |                              |   |   |   |   |
| 18 |                              |   |   |   |   |
| 19 |                              |   |   |   |   |

Executing this function returns the positive **critical value**, which is **2.200985**. Since the t-distribution is symmetrical, the rejection region is defined by two boundaries: the area less than -2.200985 and the area greater than +2.200985. If the absolute value of the [test statistic](#) exceeds 2.200985, we conclude that the results demonstrate [statistical significance](#).

### Example 3: Calculating the Critical Value for a One-Tailed Z-Test

In the case of a z-test, particularly when calculating the critical threshold for a one-tailed test (e.g., left-tailed), the process is streamlined as it relies exclusively on the alpha level, due to the nature of the [Standard Normal Distribution](#). If we select a standard [significance level](#) of 0.05, this value is directly inputted into the **NORM.S.INV** function in [Google Sheets](#):

|    | A                          | B | C | D |
|----|----------------------------|---|---|---|
| A1 | $\text{=NORM.S.INV}(0.05)$ |   |   |   |
| 1  | -1.644853625               |   |   |   |
| 2  |                            |   |   |   |
| 3  |                            |   |   |   |
| 4  |                            |   |   |   |
| 5  |                            |   |   |   |
| 6  |                            |   |   |   |
| 7  |                            |   |   |   |
| 8  |                            |   |   |   |
| 9  |                            |   |   |   |
| 10 |                            |   |   |   |
| 11 |                            |   |   |   |
| 12 |                            |   |   |   |
| 13 |                            |   |   |   |
| 14 |                            |   |   |   |
| 15 |                            |   |   |   |
| 16 |                            |   |   |   |
| 17 |                            |   |   |   |
| 18 |                            |   |   |   |
| 19 |                            |   |   |   |

Upon execution, the resulting **z-critical value** is **-1.64485**. This figure is recognized widely in statistics as the boundary for a one-tailed test conducted at the 95% confidence level. Any calculated [test statistic](#) lower than this value would fall into the critical region, leading to the rejection of the null hypothesis.

#### Example 4: Defining Critical Boundaries for a Two-Tailed Z-Test

For a two-tailed z-test, the risk of error (alpha) is symmetrically distributed across both the positive and negative extremes of the distribution. If we select an alpha of 0.05, we must conceptually split this value, placing 0.025 in the lower tail and 0.025 in the upper tail. To find the lower critical boundary using the **NORM.S.INV** function, we must input the probability corresponding to the area in the lower tail ( $0.05 / 2 = 0.025$ ).

|    | A                            | B | C | D |
|----|------------------------------|---|---|---|
| A1 | $\text{=NORM.S.INV}(0.05/2)$ |   |   |   |
| 1  | -1.959963986                 |   |   |   |
| 2  |                              |   |   |   |
| 3  |                              |   |   |   |
| 4  |                              |   |   |   |
| 5  |                              |   |   |   |
| 6  |                              |   |   |   |
| 7  |                              |   |   |   |
| 8  |                              |   |   |   |
| 9  |                              |   |   |   |
| 10 |                              |   |   |   |
| 11 |                              |   |   |   |
| 12 |                              |   |   |   |
| 13 |                              |   |   |   |
| 14 |                              |   |   |   |
| 15 |                              |   |   |   |
| 16 |                              |   |   |   |
| 17 |                              |   |   |   |
| 18 |                              |   |   |   |

The result of this calculation is the familiar [critical value](#) of **-1.96**. Consequently, the rejection boundaries for a two-tailed z-test at the 95% confidence level are defined as  $\pm 1.96$ . If the absolute magnitude of the calculated [test statistic](#) is greater than 1.96, the findings are considered strong evidence for rejecting the null hypothesis.

## Essential Cautions and Error Handling in Google Sheets Statistical Functions

Although the inverse distribution functions provided by [Google Sheets](#) are engineered for precision and reliability, the accuracy of the output relies entirely on the validity of the inputs provided by the user. It is crucial for analysts to ensure that all parameters adhere strictly to statistical constraints, otherwise, the functions will return an error, typically `#NUM!` or `#VALUE!`.

The core inverse functions--**T.INV**, **T.INV.2T**, and **NORM.S.INV**--are programmed to detect and flag violations of statistical domain rules. Users must be cognizant of these common error conditions to ensure clean and valid data processing:

**Non-Numeric Arguments:** An error will occur if any required argument (such as probability or degrees of freedom) is provided as text, is left blank, or refers to a cell containing non-numeric data.

**Invalid Probability Range:** The value supplied for the *probability* (alpha level or [significance level](#)) must be a number strictly between 0 and 1 (i.e.,  $0 < P < 1$ ). Inputs outside this range will result in

an error, as probabilities cannot be negative or exceed 100%.

**Invalid Degrees of Freedom:** Specifically for the t-distribution functions, the input for *deg\_freedom* must be an integer greater than or equal to 1. Since [degrees of freedom](#) are derived from sample size, they must always be a positive value.

Calculating the **critical value** is a foundational step in any rigorous [statistical significance](#) test. By leveraging the built-in inverse distribution functions in Google Sheets--specifically **T.INV**, **T.INV.2T**, and **NORM.S.INV**--researchers and analysts can quickly and accurately establish the necessary rejection boundaries for both T and Z tests. Mastery of these simple yet powerful formulas is vital for proper hypothesis testing and robust data interpretation.